4.0. DATA REQUIREMENTS FOR THE PERVIOUS LAND UPLAND LOADING MODULE (PERLND)

Data requirements for the Pervious Land Upland loading module are described below. Table 2-8 provided the links between subbasin monitoring data components and model data requirements in PERLND.

4.1. Section ATEMP

4.1.1. Time Series Data

AIRTMP	Measured air temperature, units are EF or EC. These data are obtainable from NOAA and other sources.

4.1.2. Tabular Data

ELDAT	Elevation difference between temperature gage and pervious land surface. This value is used to apply a lapse rate to input time series air temperature data when the gage elevation is significantly different than the gage datum. Units are feet or meters.
AIRTMP	Initial air temperature over pervious land segment at start of simulation run. Units are EF or EC.

4.2. Section PWATER

4.2.1. Time Series

PREC	Precipitation in units of inches or mm for the time interval of the data. Input time series may be scaled by a constant value if desired. The most useful time series will match or have a more frequent data interval than the selected simulation time step. The model has the capability to aggregate or dissaggregate the data mathematically to produce daily totals from hourly rainfall or distribute a daily total into equal hourly increments. The model does not have the means to distribute a daily total into an hourly distribution to develop a 'pseudo-event' in a statistically meaningful way. Such a study is a typical modeling task that must be prepared externally. Precipitation input time series are generally available from the National Climatic Data Center and other local sources.

PETINP The potential evapotranspiration (E-T) time series provides a maximum limit for the evapotranspiration demand which may occur. Units are inches or mm. The model allocates E-T demand amongst the interception storage and the various conceptual soil layers. Thus, it is possible that the total E-T demand may not be satisfied during dry conditions.

Pan evaporation data provide a useful data source for estimating actual evapotranspiration or open water evaporation. Pan evaporation data are useful because they are reflective of combined factors of solar energy inputs, relative humidity, and wind conditions.

Factored pan evaporation data may be used to provide the input time series for potential evapotranspiration. A factor of approximately 0.7 applied to the measured pan evaporation will provide reasonable results as a starting point for simulation. This value can be further adjusted to reflect local observations for evapotranspiration. If available data warrant, assignments can be made for various land cover types and irrigation practices to generate a more representative area-weighted E-T demand for each subbasin. For example, irrigated crops and pasture grasses may consume amounts of water greatly in excess of rainfall if the water is available. Simulation of this phenomenon may be of interest in the Estero Bay Watershed due to the importance of the overall water balance.

Normally, measured pan evaporation does not vary significantly within a sizable uniform geographic area and a review of the records will show that many Florida stations are very similar. One nearby time series record may suffice for the Estero Bay area. Two time series might be used if the data are available and there is reason to believe that inland and coastal conditions vary significantly.

Measured E-T data should be used for guidance if available, with the caveat that measurements from small test sites do not often translate well to larger watershed areas. One limitation of pan evaporation data is that the annual peak is out of phase with the peak in actual vegetative demand. The vegetative peak typically occurs during the spring and early summer peak growth phase while peak pan evaporation occurs during the higher temperatures later in the summer. Crop demand is further governed by local farming practices. This phase shift is not a serious limitation but should be given some consideration to fully understand the timing of water demand.

4.2.2. Tabular Data

4.2.2.1. Table PWAT-PARM1

This table contains program control flags to specify modeling options. In particular, certain monthly varying parameters are enabled via this table. Parameters which may be varied monthly will be identified below as they are encountered in the single value tables.

4.2.2.2. Table PWAT-PARM2

FOREST This parameter is irrelevant in the simulation unless snow is simulated.

LZSN The 'lower zone nominal storage' provides an index to a portion of the pervious land segment water storage. Total lower zone storage may range from zero to about 2.5 times the 'nominal' storage. This parameter is related to soil properties although no physically-based measure will provide an exact value. Successful simulation has been executed with assignments based on general soil texture classification. This is a critical parameter for calibration.

An extensive database was collected from numerous instrumented sites during the Florida Institute of Phosphate Research (FIPR) Hydrologic Model (FHM) development process. FHM employs HSPF for surface water simulation and USGS MODFLOW for groundwater. The model development effort supported extensive calibration of LZSN and many other HSPF hydrologic parameters for northern and central Florida soils. Units are soil moisture storage in inches or millimeters.

INFILT This parameter is **not** the soil infiltration rate. This value functions as an index to soil infiltration. This parameter is the probably the most sensitive model parameter for general partition of precipitation to direct surface runoff. Units are in/hr or mm/hr.

LSUR — This parameter is the length of the overland flow plane. In our experience with Florida simulations, best results have been achieved when the flow plane length is determined as the greatest overland flow length from the furthest point in the subbasin to the point where flow enters the reach. In highly channelized agricultural systems with extensive field ditching, this parameter should be appropriately set to reflect the short travel distance of overland flow to better simulate the rapid concentration of flow. Units are distance in feet or meters.

SLSUR — This parameter is the slope of the overland flow plane. The use of the average slope of the subbasin has proven effective in many Florida simulations. A useful method for determining the land surface slope involves tracing multiple flow paths from equally spaced starting points around the perimeter of the subbasin and recording elevation change and flow distance to the point where flow enters the reach. For a typical subbasin area, the average derived from about 10 to 20 flow paths will provide a good measure of the land surface slope. Units are elevation change per distance as ft/ft or m/m.

KVARY — This parameter enables an optional non-exponential decay for groundwater recession flow if a non-zero value is specified. This parameter works in tandem with GWVS described below and will generally accelerate groundwater outflow. Units for KVARY are 1/in. or 1/mm. Adjustments to the standard groundwater recession algorithm using these factors has not proven helpful in our experience in Florida, where the modeler's task is normally to prolong this discharge to match the slow recession rates and extended periods of discharge.

AGWRC — This is the basic groundwater recession constant. This parameter controls the groundwater outflow rate as a fraction of the available storage. When there is no additional inflow this results in an exponential decay function. Values in the range from 0.9 to 0.999 have been used successfully in Florida simulations. Units are 1/day.

4.2.3. Table PWAT-PARM3

PETMAX	These temperature parameters to limit evapotranspiration during cold conditions. Not used unless snow is simulated.
PETMIN	Same as above.
INFEXP	Exponent in the infiltration equation.
INFILD	Ratio of maximum to mean infiltration over the pervious land surface. This parameter is intended to account for variability within the subbasin.
DEEPFR	This is the fraction of groundwater inflow which will report to deep groundwater. A suitable value can be determined from annual groundwater inflow rates and an examination of the annual water balance.
BASETP	Fraction of remaining potential evapotranspiration which can be satisfied from groundwater outflow.
AGWETP	Fraction of remaining potential evapotranspiration which can be satisfied from active groundwater storage.

4.2.4. Table PWAT-PARM4

CEPSC	This is the interception storage. Values may be assigned by land use/cover to develop an area-weighted average for the subbasin. These data can be developed from standard interception estimates. Units are depth in inches or mm.
UZSN	This is the upper zone nominal storage. This parameter functions as an index to upper zone storage. Upper zone storage is limited to three times the 'nominal' storage. This is a sensitive model parameter for direct surface runoff generation. Units are depth in inches or mm.
NSUR	This is the Manning's n friction factor for the overland flow plane. Values may be assigned by land use/cover type to develop area-weighted averages for each subbasin. Standard estimates for overland flow form a useful starting point for modeling that can be fine-tuned to reflect unique conditions in the watershed.

INTFW This is the interflow inflow parameter. Model documentation regarding interflow indicates that this flow could represent lateral flows resulting from a shallow impermeable layer retarding downflow. The provided value is applied to surface detention storage to take a portion of the flow directed toward the lower layers. Units are a fraction of the potential downward flow.

IRC This is the interflow recession constant. The parameter is used to control the outflow rate decay from the interflow storage. Units are the rate per day.

LZETP This is the lower zone evapotranspiration parameter, which functions as an index to deeply rooted vegetation. Values range from 0 to 1, with a value of 1 assuring that remaining E-T demand will be fully satisfied from the lower zone storage, if possible.

4.2.5. Monthly Tables

Monthly varying parameter values can be provided for interception storage, upper zone nominal storage, Manning's n, interflow inflow and recession, and the lower zone E-T parameter. The monthly varying parameter values can be used to advantage to simulate changes in vegetative cover and soil conditions during the annual cycle. Estimates of standing crop/cover are available in the literature for a variety of natural systems and agricultural crops.

4.2.6. Evapotranspiration Partitioning

Limited guidance is available for evapotranspiration partitioning within HSPF. Some effort can be made to reflect vegetation changes over the year with LZETP. The most important consideration is to adjust the E-T demand and the various parameters so that the total E-T production is reflected properly as part of the overall water balance.

4.2.7. Table PWAT-STATE1

CEPS Initial interception storage in inches or mm.

SURS	Initial surface storage in inches or mm.
UZS	Initial upper zone storage in inches or mm.
IFWS	Initial interflow storage in inches or mm.
LZS	Initial lower zone storage in inches or mm.
AGWS	Initial active groundwater storage in inches or mm.
GWVS	Index to groundwater slope in inches or mm. This parameter works together with KVARY to adjust the active groundwater outflow and recession rate. Please see discussion for KVARY, above. These parameters may be considered shaping factors for the groundwater outflow.

4.2.8. Guidelines for Initial Storages

Initial storages are important for getting the model to equilibrium early in the simulation run. Initial storages can be used to set the model for specific antecedent conditions. This is particularly important for short-term event simulations. When longer simulations are performed, initial storages are less important because the model algorithms will rapidly move toward the conditions dictated by the input time series forcing functions. Some of the storages must have a non-zero initial content to avoid problems with the calculations and possible failure to execute. As a guideline for normal antecedent conditions, UZS can be started at a value equal to UZSN. LZS may typically range from 1 to 2 times LZSN based on soils characteristics.

4.2.9. Data Sources

As a general guideline, the monitoring program will not directly provide parameter values for the PWATER section of the model. The monitoring program will provide significant guidance to allow the modeler to develop suitable parameter values through the process of model calibration and verification.

4.3. Section SEDMNT

4.3.1. Time Series Data

SLSED Optional time series for lateral input sediments from outside of the subbasin.

4.3.2. Tabular Data

4.3.2.1. Table SED-PARM1

This table contains program control parameters for sediment simulation to select the method of simulation and specify optional monthly inputs for vegetative cover and vertical sediment input.

4.3.2.2. Table SED-PARM2

SMPF This supporting management practice factor may be used to arbitrarily reduce soil erosion following implementation of erosion control management practices.

KRER Coefficient in soil detachment equation.

JRER Exponent in soil detachment equation.

AFFIX Fractional rate of decrease in soil detached sediment storage per day resulting from compaction. Units are the rate of decrease per day.

COVER Fraction of soil shielded from erosion by rainfall. This parameter may be developed by assigning values based on vegetative cover or impervious area (land use) to develop an area-weighted value for the subbasin.

NVSI This parameter is the net vertical sediment input and may be derived from bulk precipitation data. Units are lb/acre-day or kg/ha-day.

4.3.2.3. Table SED-PARM3

KSER Coefficient in detached sediment washoff equation.

JSER	Exponent in detached sediment washoff equation.
KGER	Coefficient in matrix soil scour equation.
JGER	Exponent in matrix soil scour equation.

4.3.3. Monthly Tables

Monthly values may be provided for COVER to simulate changes in area shielded from erosion. Monthly values may also be input for NVSI to show changes in net vertical sediment input. By using negative values, this mechanism can be used to simulate net sediment removal by wind at various times throughout the year.

4.3.3.1. Table SED-STOR

DETSB	Initial storage of detached sediment. Units are tons/acre or tonnes/ha.

4.4. Section PSTEMP

4.4.1. Table PSTEMP-PARM1

TSOPFG	Flag set to specify method used to determine upper and lower/groundwater layer temperatures. As groundwater temperature data are readily available, specifying the groundwater layer temperature is a reasonable data requirement to provide the desired soil temperature profile. Other flags in the table can activate the use of monthly varying parameters to ensure closer year-round soil temperature estimation.

4.4.2. Table PSTEMP-PARM2

ASLT	Surface layer temperature when air temperature is 32EF (0 EC). Intercept in regression equation.
BSLT	Slope of surface layer temperature regression equation.
ULTP1	Upper layer temperature equation intercept.
ULTP2	Slope of upper layer temperature

LGTP1 Lower layer/groundwater layer soil temperature.

LGTP2 Not used.

These parameters provide a means for the model to calculate subsurface soil temperatures and can be readily adjusted to fit the available data for the watershed to provide a reasonable temperature profile. Monthly tables may be optionally provided for all of these parameters to reflect changes in soil temperature over the annual cycle. Soil temperature values and the range of variation throughout the year can be determined from groundwater monitoring wells.

4.5. Section PWTGAS

4.5.1. Table PWT-PARM1

This table contains flags to enable monthly varying interflow and groundwater outflow DO and CO_2 concentrations.

4.5.2. Table PWT-PARM2

ELEV This parameter is the elevation of the land surface above sea level and is used to adjust saturation concentrations of dissolved gasses in surface outflow.

IDOXP The concentration of dissolved oxygen in interflow outflow. Units are mg/l.

ICO2P The concentration of dissolved CO_2 in interflow outflow. Units are mg/l.

ADOXP The concentration of dissolved oxygen in active groundwater outflow. Units are mg/l.

ACO2P The concentration of dissolved CO_2 in active groundwater outflow. Units are mg/l.

4.5.3. Monthly Tables

Monthly varying values for interflow and groundwater DO and CO_2 outflow concentrations may optionally be provided.

4.5.4 Initial Value Tables

Initial values may be provided for water temperature and gas concentrations. These tables are not required because values will be calculated or derived from other input data during the initial phase of the modeling run.

4.6. Section PQUAL

Section PQUAL is very flexible and can be set up to model the sediment-associated and flow-associated nutrient loadings produced by uplands in the Estero Bay Watershed.

4.6.1. Table NQUALS

NQUAL — Number of quality constituents to be simulated. Up to ten constituents may simulated, but this limit may be more restrictive than first glance indicates. Constituents may be associated with sediment, overland flow, interflow outflow or groundwater outflow. Each outflow uses a separate modeling routine. Thus, for example, use of PQUAL to simulate phosphorus outflows which included all components would consume four of the ten available constituents.

4.6.2. Table QUAL-PROPS

This table is a descriptive table to label the quality constituent (QUALID) and units (QTYID) and identify whether it is sediment-associated (QUALSD), overland flow associated (QUALOF), interflow outflow associated (QUALIF), or groundwater outflow associated (QUALGW). Additional flags specify whether monthly varying inputs will be provided and how those should be used.

4.6.3. Table QUAL-INPUT

This table is used to specify various potency factors, accumulation rates and storages for the different available simulation mechanisms. Quantity units are user-defined.

The following variables are applicable only if the constituent is a QUALSD (associated with sediment):

1) POTFW, the washoff potency factor. Units are quantity/ton or qty/tonne.
2) POTFS, the scour potency factor. Units are qty/ton or qty/tonne.

A potency factor is the ratio of constituent yield to sediment (washoff or scour) outflow.

The following variables are applicable only if the constituent is a QUALOF (associated with surface outflow):

1) SQO, the initial storage of QUALOF on the surface of the PLS. Units are qty/ac or qty/ha.
2) ACQOP, the rate of accumulation of QUALOF. Units are qty/ac-day or qty/ha-day
3) SQOLIM, the maximum storage of QUALOF. Units are qty/ac or qty/ ha.
4) WSQOP, the rate of surface runoff which will remove 90% of stored QUALOF per hour. Units are in/hr or mm/hr.

IOQC This parameter is the concentration of the constituent in interflow outflow if this is a QUALIF (associated with interflow outflow). This is treated as a constant value applicable throughout the run. Units are qty/ft^3 or qty/l.

AOQC This parameter is the concentration of the constituent in active groundwater outflow if this is a QUALGW (associated with groundwater outflow). This is treated as a constant applicable throughout the run. Units are qty/ft^3 or qty/l.

If monthly values are being supplied for any of these quantities, the values provided in this table are not relevant; instead, the system expects and uses values supplied in the monthly tables.

4.6.4. Monthly Tables

Monthly varying tables may be supplied for potency factors associated with sediment washoff and scour, the accumulation rate and maximum storage for surface outflow constituents, and the interflow and groundwater concentrations.

4.7. Section MSTLAY

4.7.1. Table MST-PARM

This table contains factors which may be used to retard solute percolation rates. This feature was implemented in an attempt to overcome a limitation of the model algorithms which resulted in excessive leaching of solutes.

SLMPF This parameter affects percolation from the surface layer storage to the upper layer principal storage.

ULPF This parameter affects percolation from the upper layer principal storage to the lower layer storage.

LLPF This parameter affects percolation from the lower layer storage to the active and inactive groundwater.

No other tables available in MSTLAY will be required.

4.8. Section NITR

4.8.1. Table SOIL-DATA

<depths> The first four values are the depths (thicknesses) of the surface, upper, lower and groundwater layers respectively. Units are inches or cm.

<bulkdens> The second group of four values are the corresponding bulk densities of the soil in those layers. Units are lb/ft^3 or gm/cc.

The depth and bulk density are multiplied together by the program to obtain the mass of soil in each layer. This is used to compute the concentrations of adsorbed chemicals. Data from the local soils surveys can be used to develop these input parameters.

4.8.2. Table NIT-FLAGS

This table contains program control flags to specify the use of single or monthly-varying nitrogen uptake and the method for adsorption and desorption of ammonium. If the Freundlich isotherm method is used, the number of iterations may be specified. The recalculation frequency for biochemical and chemical reactions may also be specified.

4.8.3. Table NIT-UPTAKE

SKPLN, UKPLN, LKPLN and AKPLN are the plant nitrogen uptake reaction rate parameters for the surface, upper, lower and active groundwater layers, respectively. This table is used if only a single plant uptake value will be supplied. The approach to developing these input parameters is to initially determine overall plant uptake and then assign portions of the rate to each soil layer in accordance with the plant root zone - depth distribution. Standing crop data can be determined for the annual cycle to allow use of monthly varying rates described below.

4.8.4. Table MON-NITUPT

This table specifies monthly-varying nitrogen plant uptake rates for the surface, upper, lower and groundwater layers.

4.8.5. Table NIT-FSTGEN

NO3UTF and NH4UTF are parameters intended to designate which fraction of nitrogen plant uptake comes from nitrate and ammonium, respectively. Their sum should be 1.0 Information on this partitioning may be available from plant nutrient uptake studies.

This table specifies the temperature coefficients (theta) for the various first order reactions:

THPLN	Plant uptake
THKDSA	Ammonium desorption (Not needed if Freundlich isotherm is used.)
THKADA	Ammonium adsorption (Not needed if Freundlich isotherm is used.)
THKIMN	Nitrate immobilization
THKAM	Organic N ammonification
THKDNI	NO_3 denitrification
THKNI	Nitrification
THKIMA	Ammonium immobilization

4.8.6. Table NIT-FSTPM

The parameters in this table are the first-order reaction rate parameters for given layer of soil:

KDSAM	Ammonium desorption rate (Not needed if Freundlich isotherm is used.)
KADAM	Ammonium adsorption rate (Not needed if Freundlich isotherm is used.)
KIMNI	Nitrate immobilization rate
KAM	Organic N ammonification rate
KDNI	Denitrification rate
KNI	Nitrification rate
KIMAM	Ammonium immobilization rate

These values must be provided for each of the four soil layers; surface, upper, lower, and active groundwater. It is important to note that the rates provided to HSPF are considered 'optimum' rates occurring at 35EC. Literature references may provide data at 20EC or some other basis which will require adjustment.

4.8.7. Table NIT-CMAX

CMAX	This parameter is the maximum solubility of ammonium in water and is used only if adsorption/desorption is simulated using single-value Freundlich method. Units are ppm.

4.8.8. Table NIT-SVALPM

XFIX	This parameter is the maximum concentration (on the soil) of pesticide which is permanently fixed to the soil. Units are ppm.
K1, N1	These parameters are the coefficient and exponent parameters, respectively, for the single value Freundlich adsorption/desorption equation.

4.8.9. Table NIT-STOR1

This table specifies the initial storages of N in the four soil layer storages and the plant N derived from each layer. The table repeats for each layer.

ORGN	Organic N, units are lb/acre or kg/ha.
AMAD	Adsorbed ammonium, units are lb/acre or kg/ha.
AMSU	Solution ammonium, units are lb/acre or kg/ha.
NO3	Nitrate, units are lb/acre or kg/ha.
PLTN	N stored in plants, derived from each layer, units are lb/acre or kg/ha.

4.8 10. Table NIT-STOR2

IAMSU	Initial storage of ammonium in upper layer transitory (interflow) storage. Units are lb/acre or kg/ha.
INO3	Initial storage of nitrate in upper layer transitory (interflow) storage. Units are lb/acre or kg/ha.

4.9. Section PHOS

4.9.1. Table SOIL-DATA

This table is the same as described for Section NITR. The table is required only once if both NITR and PHOS are active during the run.

<depths>	The first four values are the depths (thicknesses) of the surface, upper, lower, and groundwater layers respectively. Units are inches or cm.
<bulkdens>	The second group of four values are the corresponding bulk densities of the soil in those layers. Units are lb/ft^3

The depth and bulk density are multiplied together by the program to obtain the mass of soil in each layer. This is used to compute the concentrations of adsorbed chemicals. Data from the local soils surveys can be used to develop these input parameters.

4.9.2. Table PHOS-FLAGS

This table contains program control flags to specify the use of single or monthly-varying phosphorus uptake and the method for adsorption and desorption of phosphorus. If the Freundlich isotherm method is used, the number of iterations may be specified. The recalculation frequency for biochemical and chemical reactions may also be specified.

4.9.3. Table PHOS-UPTAKE

SKPLP, UKPLP, LKPLP and AKPLP are the plant nitrogen uptake reaction rate parameters for the surface, upper, lower and active groundwater layers, respectively. This table is used if only a single plant uptake value will be supplied. The approach to developing these input parameters is to initially determine overall plant uptake and then assign portions of the rate to each soil layer in accordance with the plant root zone - depth distribution. Standing crop data can be determined for the annual cycle to allow use of monthly varying rates described below.

4.9.4. Table MON-PHOSUPT

This table specifies monthly-varying phosphorus plant uptake rates for the surface, upper, lower and groundwater layers.

4.9.5. Table PHOS-FSTGEN

This table specifies the temperature coefficients (theta) for the various first order reactions:

THPLP	Plant uptake
THKDSP	Phosphate desorption (Not needed if Freundlich isotherm is used.)
THKADP	Phosphate adsorption (Not needed if Freundlich isotherm is used.)
THKIMP	Phosphate immobilization
THKMP	Organic P mineralization

4.9.6. Table PHOS-FSTPM

The parameters in this table are the first-order reaction rate parameters for given layer of soil:

KDSP	Phosphate desorption (Not needed if Freundlich isotherm is used.)
KADP	Phosphate adsorption (Not needed if Freundlich isotherm is used.)
KIMP	Phosphate immobilization
KMP	Organic P mineralization

These values must be provided for each of the four soil layers; surface, upper, lower, and active groundwater. It is important to note that the rates provided to HSPF are considered 'optimum' rates occuring at 35EC. Literature references may provide data at 20EC or some other basis which will require adjustment.

4.9.7. Table PHOS-CMAX

CMAX	This parameter is the maximum solubility of phosphate. Units are ppm.

4.9.8. Table PHOS-SVALPM

XFIX	This parameter is the maximum concentration of phosphorus which is permanently fixed to the soil. Units are ppm.
K1, N1	These parameters are the coefficient and exponent, respectively, for the Freundlich adsorption/desorption equation.

4.9.9. Table PHOS-STOR1

This table specifies the initial storages of P in the four soil layer storages and the plant P derived from each layer. The table repeats for each layer.

ORGP	Organic phosphorus, units are lb/acre or kg/ha.
P4AD	Adsorbed phosphate, units are lb/acre or kg/ha.
P4SU	Solution phosphate, units are lb/acre or kg/ha.

PLTP Plant phosphorus derived from layer, units are lb/acre or kg/ha.

4.9.10. Table PHOS-STOR2

IP4SU Initial storage in the upper layer transitory (interflow) storage, units are lb/acre or kg/ha.